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Response to an exercise intervention after endometrial cancer: Differences between obese and non-obese survivors

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Abstract

Objective—The objective of this paper is to describe baseline differences between obese and non-obese endometrial cancer survivor in anthropometrics, exercise behavior, fitness, heart rate and blood pressure, and quality of life, and to analyze whether the effect of a home-based exercise intervention on these outcomes differed for obese and non-obese participants.

Methods—One hundred post-treatment Stage I–IIIa endometrial cancer survivors participated in a single arm 6 month study in which they received a home-based exercise intervention. Cardiorespiratory fitness, anthropometrics, and exercise behavior were measured every two months, and quality of life (QOL) and psychological distress were measured at baseline and 6 months.

Results—Adjusting for potential confounders, at baseline obese survivors had poorer cardiorespiratory fitness (p=.002), higher systolic blood pressure (p=.018), and lower physical functioning (p<.001) and ratings of general health (p=.002), and more pain (p=.037) and somatization (.002). Significant improvements were seen in exercise behavior, resting heart rate, systolic blood pressure, and multiple QOL domains over the course of the intervention. Obese survivors had less improvement in exercise behavior and cardiorespiratory fitness than non-obese survivors, but there were no differences with regard to improvements in QOL and stress.

Conclusions—Home based exercise interventions are beneficial to endometrial cancer survivors, including those whose BMI is in the obese range. While obese survivors have lower levels of physical activity and fitness, they experienced similar activity, fitness, quality of life and mental health benefits. Exercise should be encouraged in endometrial cancer survivors, including those who are obese.

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Keywords

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Endometrial cancer is the most common gynecologic cancer and is the fourth most common cancer among women in the United States (1–3). The average five-year survival rate is high, approximately 84%, due to early detection and advances in treatment (2). Given the prevalence and high survival rate of endometrial cancer, these survivors make up a relatively large proportion of female cancer survivors, warranting research to improve their health and quality of life.

Obesity and inactivity are the most significant modifiable risk factors for endometrial cancer (4). A high proportion of endometrial cancer survivors are obese (5), and obesity is associated with a lower quality of life (QOL) after active treatment (6, 7). Additionally, survivors often experience obesity-related co-morbidities such as type II diabetes and hypertension (4). Higher mortality risk has been demonstrated for survivors who are morbidly obese (8) or have obesity-related conditions such as diabetes (9, 10). Physical activity decreases the risk of endometrial cancer, while sedentary behavior increases risk (11–13).

A growing evidence points to the importance of exercise to the health and quality of life of endometrial survivors (6, 7, 14) as well as survivors of other types of cancer (15, 16). However, there are few studies in endometrial cancer survivors, and we do not know if exercise is equally effective for obese and non-obese survivors. Randomized trials supporting the benefits of exercise for cancer survivors have led to national recommendations (17): 150 minutes/week of moderate or 75 minutes/week of vigorous intensity aerobic activity, and strength training of all major muscle groups twice a week, with special precautions recommended for those with particular medical conditions such as severe anemia or bone metastases. However, we know little about how obesity affects survivors' ability to participate in and benefit from exercise. The objective of this paper is to describe baseline differences between obese and non-obese endometrial cancer survivors in anthropometrics, exercise behavior, fitness, heart rate and blood pressure, and QOL, and to analyze whether the effect of a home-based exercise intervention on these outcomes differed for obese and non-obese participants.

METHODS

Design and Participants

This paper is a secondary analysis of data from the Steps to Health study, a 6-month longitudinal study to assess predictors of exercise behavior in endometrial cancer survivors who received a home-based exercise intervention. Specific details on study methodology have been published previously (18, 19). Participants were 100 women diagnosed with Stage I, II, or IIIa endometrial cancer who were at least 6 months post-treatment with no evidence of disease. Women were excluded if they had met recommendations for physical activity (20, 21) for ≥6 months, or were judged by their physician to have health problems that contraindicated participation in home-based exercise and a submaximal exercise test.

Participants were recruited from the Gynecologic Oncology Center and satellite clinics at The University of Texas MD Anderson Cancer Center (UTMDACC) and at a private gynecologic oncology practice in Houston, TX. At the UTMDACC sites, potentially eligible survivors were approached at an appointment or contacted by mail and telephone. At the private clinic, a potential study participant was first approached by the health care provider,

and if interested the recruitment coordinator would discuss the study with her. The UTMDACC institutional review board approved study procedures.

Procedure

Assessments of weekly exercise minutes, anthropometrics, and fitness were conducted at baseline, 2 months, 4 months, and 6 months. Assessment of psychological distress and QOL was conducted at baseline and 6 months.

At baseline participants completed 7 days of home-based assessment (daily recording of exercise and wearing an accelerometer), then completed a laboratory assessment involving assessment of anthropometrics and cardiorespiratory fitness and completion of questionnaires, followed by 5 more days of home-based assessment. This assessment routine was repeated at 2, 4, and 6 months except that the home-based assessment was done for only 5 days before and after the laboratory assessment

Home-based assessment—Participants used a handheld computer (Hewlett-Packard iPAQ RX1950) to record their exercise. To capture objective data on physical activity, participants wore a GT1M accelerometer (Actigraph L.L.C., Pensacola, FL), which collected activity count data in 60-second epochs. It was worn at the waist during waking hours except when participants were in the water (e.g., showering or swimming). These daily reports of exercise and accelerometer data provide a measure of daily minutes of exercise.

Laboratory assessment—The laboratory assessment consisted of a 2- to 3-hour session held at UTMDACC. Height and weight were measured with the participant in light clothing and without shoes, using a stadiometer and a digital scale, respectively. Waist circumference was measured to the nearest 0.1 cm by placing a cloth tape measure around the participant's body in a horizontal plane at the narrowest part of the torso. Two measurements were taken, and the mean circumference was used. Participants completed questionnaires related to quality of life and exercise, and then completed a submaximal cardiorespiratory fitness test on a cycle ergometer. Prior to the exercise test, resting ECG, heart rate, and blood pressure was measured. Participants exercised at 20 Watts (W) for 2 minutes, followed by increases of 20 W every 2 minutes until they reached 85% of predicted maximum heart rate, a respiratory exchange ratio equal to 1, or volitional fatigue. An RER of 1 or 85% of age predicted maximum heart rate was reached by 78% at baseline, 86% at month 2, 87% at month 4, and 88 % at month 6. The rest reached volition fatigue before meeting either criterion. Blood pressure, heart rate, and ratings of perceived exertion (RPE) were measured at the end of each 2-minute period during the exercise stage. Breath-by-breath measurements of Watts, VO2 (ml/kg/min), VO2 (L), VCO2 (L), VE (L), VE/VO2 (L), VE/VCO2 (L), METs, and caloric expenditure (kcal/min) were ascertained continuously throughout each test using a metabolic measurement cart. During the test and in the recovery period participants' hearts were monitored for rhythm and rate with continuous 12- lead ECG readings. During recovery, blood pressure was monitored and recorded every minute. Because a number of the participants were on medications that affected heart rate response, which interfered with prediction of $VO2_{max}$, we used a regression formula using the increase in RPE to predict maximal oxygen uptake (22, 23).

Measures

Quality of life—The SF-36 is a 36-item self-report measure of health-related quality of life comprising eight health concepts: physical function, social function, pain, mental health, energy and fatigue, general health perceptions, role limitations caused by physical problems, and role limitations caused by emotional problems (24). Internal consistency reliability is

high for its eight scales, ranging from 0.78 to 0.93. The QLACS focuses on five cancer specific domains (appearance concerns, financial problems, distress over recurrence, family-related distress, and benefits of cancer) and seven general domains (negative feelings, positive feelings, cognitive problems, sexual problems, physical pain, fatigue, and social avoidance). Internal consistency is acceptable at .72 or higher for each domain (25).

The Brief Symptom Inventory-18 (BSI-18) which measures depression, anxiety, and somatization, was used to assess psychological distress. Internal reliability estimates, based on a sample of 1,134, are very good, ranging from. 74 – .89 (26). Stress was assessed using the Perceived Stress Scale (PSS), which provides a measure of individual's global perceived stress level, or the general tendency to view one's own life as being unpredictable, out of control and overwhelming (27).

Exercise—During the home assessment participants recorded the duration of exercise as it was completed (real-time minutes) and at the end of the day (night-time diary), and also wore the accelerometer. Because on some days participants were missed assessments, we used a combination of these three methods for the final measure of exercise. If real-time minutes were not reported, we used the minutes of exercise reported in the night-time diary. If both real-time minutes and night-time minutes were missing, we used the minutes recorded by the accelerometer (minutes of moderate or greater intensity activity performed in bouts of at least 10 minutes). The 3 methods had moderate degrees of intercorrelation for days on which participants had data from all methods (real-time and night-time diary: $r=0.57$; real-time and accelerometer: $r=0.50$; night-time diary and accelerometer: $r=0.48$; $p<.0001$). Correlation of each measure with the combined minutes variable were: real-time minutes, 0.77; night-time diary, 0.62; accelerometer minutes, 0.53 ($p<.0001$). The correlations compare favorably with other studies comparing different types of physical activity measures (28). Across all participants and assessment periods, there was a total of 3,720 possible days for which data on exercise could be obtained. Using all three data sources allowed us to calculate exercise minutes for 91% of the potential home assessment days.

Intervention

At the end of the baseline laboratory assessment, each participant received an exercise recommendation tailored to her fitness level based on ACSM guidelines (29), with the goal of gradually increasing to 30 minutes/day of moderate-intensity walking on 5 or more days per week. For participants who had difficulty walking other exercise was recommended. To encourage exercise adherence we provided telephone counseling, print materials, and a pedometer. Telephone counseling consisted of 20- to 30-minute calls provided weekly in months 1 and 2, twice a month in months 3 and 4, and once a month in months 5 and 6. Participants completed a mean of 59% of the sessions. There was no significant difference between obese and non-obese participants in the completion rate.

Analysis

Baseline data on exercise, fitness, anthropometrics, and quality of life were compared between obese and non-obese participants using t-tests and linear regression analyses, adjusting for age, education, race, time since diagnosis, disease stage, and treatment type (surgery, surgery plus radiation, or surgery plus other treatment). Observations with missing data were not included in analyses of baseline data. Baseline data analyses were performed with R version 3.0.1 (R Foundation for Statistical Computing, Vienna, Austria). In addition to the baseline comparisons, longitudinal data across the 6 months period were analyzed. Differences between obese and non-obese participants for activity, fitness, and anthropometrics were assessed using repeated measures analysis. The repeated measures

model accounted for the correlations among observations arising from the same individuals over time, by modeling the covariance structure (30). In the model selection process, different patterns of covariance structures were specified to find the most suitable model. Model selection was evaluated by the Akaike Information Criterion (AIC). All repeated measures analyses controlled for race, education, age, time since diagnosis, disease stage, and treatment type. In the repeated measures model, the covariance structure is modeled by specifying a structured (e.g. diagonal, compound symmetry, AR(1), or ARMA(1,1)), or unstructured form in the model. In repeated measures models, observations were assumed to be missing at random. Hence, all available data were used in the analyses. In other words, participants who did not have complete data for the outcome variable were still included in analyses, as long as the covariate data for the assessment time was complete.

Model parameters were estimated by restricted maximum likelihood (REML), to obtain unbiased estimates of the fixed-effects and covariance parameters (31). Repeated measures models were implemented using SAS version 9.3 (SAS Institute, Cary, NC), procedure PROC MIXED, with REPEATED statement to specify correlations structures within individuals.

RESULTS

Baseline characteristics

We identified 643 survivors potentially eligible for the study. Of these, 39 were ineligible on additional screening, and 270 were incompletely screened (i.e., did not respond to letters and phone calls, and did not have appointments during the recruitment period). Of the remaining 334 women, 192 were not interested in the study, and 42 were initially interested but did not complete either the consent process or the baseline assessment. Table 1 provides the characteristics of the sample. Thirty-six of the participants had a BMI <30 at baseline (non-obese), and 64 had a BMI ≥30 (obese).

Baseline differences between obese and non-obese survivors

A total of 100 participants were included in baseline analyses. At baseline, there were no significant differences between obese and non-obese survivors in resting heart rate, systolic blood pressure, diastolic blood pressure, or daily minutes of exercise (Table 2). However, obese participants had larger waist circumference (p<.001) and poorer cardiorespiratory fitness, whether estimated using RPE (p=.005) or heart rate (p<.001). They reported more somatization on the BSI-18 (p=.004), poorer physical functioning (p<.001), and more pain (both the SF-36 and QLACS scales, p=.032 and p=.010, respectively), poorer perceived health (p=.001), more distress recurrence (p=.002), and more financial problems (p=.044). Controlling for possible confounders of age, education, race, time since diagnosis, disease stage, and treatment type (surgery, surgery and radiation, surgery and other treatment), all associations were still significant in the same direction, except for financial problems (p=.122). Additionally, adjusted analyses showed that obese participants had higher systolic blood pressure (p=.018) after adjustment. In the adjusted models, time since diagnosis was associated with smaller waist circumference (p=.012), less social avoidance (p=.048), and lower anxiety score (p=.023). Disease stage and treatment were not associated with any dependent variable.

Response to intervention

Repeated measures analyses were performed adjusting for age, education, race, time since diagnosis, disease stage, and treatment type to assess associations between obesity and exercise behavior, cardiorespiratory fitness, anthropometrics, resting heart rate, and blood pressure. Data from one hundred participants who completed baseline measurements were

considered in repeated measures analyses. Analyses included all available observations at each assessment time (Month 2: n=87; month 4: n=83; month 6: n=79). Confounders and covariance structures were chosen using AIC criterion: all models were specified with AR(1) covariance structure.

Survivors experienced significant improvements over time in exercise minutes (p=.002), resting heart rate (p=.047), and systolic blood pressure (p=.030). The observed time trends were quadratic for minutes of exercise and resting heart rate, and linear for systolic blood pressure (Table 3). Over the entire study period, non-obese survivors had better cardiorespiratory fitness (p=.003) and systolic blood pressure (p=.016), smaller waist circumference (p<.001), and marginally longer minutes of exercise per day (p=.090). None of the interaction terms between obesity status and time were significant, indicating obese and non-obese participants did not experience differential changes in exercise behavior, resting heart rate, or blood pressure over time.

For QOL (measured at baseline and at 6 months) repeated measures analyses were performed to assess whether there were significant changes from before to after the intervention, and whether these changes differed by obesity status (Table 4). Separate models were examined for eight subscales in the SF-36, twelve subscales in the QLACS, three subscales in the BSI-18, and for the PSS. In these models, the covariance pattern was specified as AR(1) structure. All models adjusted for age, education, race, time since diagnosis, disease stage, and treatment type. On the SF-36 subscales, survivors experienced significant improvements over time in physical functioning (p<.001), perceived general health (p<.001), vitality (p<.001), and mental health (p=.029), with marginally significant changes in pain (p=.087) and role limitations due to physical problems (p=.057). Over the two periods, non-obese survivors had better physical functioning (p<.001), perceived general health (p=.001), and pain (p=.023). For QLACS subscales, survivors experienced significant improvements over time in negative feelings (p<.001), positive feelings (p=.012), cognitive problems (p=.005), pain (p=.014), sexual problems (p=.004), energy/fatigue (p=.017), social avoidance (p=.002), perceived benefits from cancer (p=.007), and distress recurrence (p=.032). Over the two periods, non-obese survivors had significantly lower pain (p=.014) and distress recurrence (p=.010) compared to obese survivors. For BSI-18 subscales, survivors experienced marginally significant mean improvements over time in somatization (p=.103) and anxiety (p=.073). Over the two periods, non-obese survivors had significantly lower mean levels for somatization (p=.003) compared to obese survivors. Lastly, survivors experienced significant improvement over time in perceived stress (p<.001). None of the interaction terms between obesity status and time were significant, indicating that there were no significant differences in the changes in QOL and distress over time.

CONCLUSIONS

Endometrial cancer survivors have a high prevalence of obesity and are less likely to be physically active than the general population (7, 32), likely due in part to the fact that these are strong risk factors for the disease (33, 34). In this study of exercise adoption in endometrial cancer survivors, 64% of the sample had a BMI in the obese range at baseline. These obesity rates exceed those of similarly aged women from the US population, where the obesity rates are 36% for women aged 40–59 and 42% for women 60 and older (35).

Obese participants in our study reported lower levels of physical activity at baseline, which paralleled findings from previous studies (7, 14). They also had higher systolic blood pressure and poorer cardiorespiratory fitness, indicating an increased risk of cardiovascular disease. This is the first study to report data on cardiorespiratory fitness levels among

endometrial cancer survivors, comparing obese and non-obese survivors. The obese survivors also reported more pain and somatization, and poorer physical functioning and perceived health. Previous surveys of endometrial cancer survivors have also identified a relationship between obesity and physical functioning and other aspects of QOL in endometrial cancer survivors (7, 32).

Survivors experienced several improvements over the course of the intervention period. Their physical activity increased, their fitness improved, and several dimensions of QOL improved, including both physical aspects (physical functioning, energy levels, pain, general health perceptions) and mental and emotional aspects (stress, negative emotions, cognitive problems, distress about recurrence). While obese survivors had lower overall physical activity and fitness, and seemed to decline more rapidly when the telephone sessions decreased in frequency, there was no difference between the two groups in the QOL improvements, indicating that even small increases in physical activity may benefit survivors' QOL. This can be beneficial information for obese survivors who may lack confidence that they can meet exercise guidelines. Results of this study indicate that even small increases in activity can improve obese survivors' QOL.

Obese survivors experienced more symptoms at baseline, which could potentially interfere with their ability to exercise. However, symptoms can also provide a motivation for exercising. A study of endometrial cancer survivors indicated that those who exercise were more likely to rate feeling better emotionally and physically as likely and important outcomes of exercise (36). Observational studies and clinical trials of exercise interventions in cancer survivors demonstrate that exercise can ameliorate symptoms such as fatigue, pain, and poor physical functioning (7, 14, 32). A small randomized study in ovarian and endometrial cancer patients tested a 12 week moderate-intensity exercise intervention, and found improvements in fatigue at the end of the intervention and at 6-month follow-up (37).

To optimize exercise behavior change, interventions may need to be tailored to the needs and preferences of obese survivors. Karvinen *et al.* (38) found that compared to endometrial cancer survivors in the normal BMI range, overweight and obese survivors were more likely to prefer receiving exercise counseling/instruction in-person and initiating the exercise training early in treatment. Thus early interventions in the cancer care setting may be more appropriate for obese survivors than home-based interventions. Intervening on both exercise and diet to encourage weight loss in endometrial cancer survivors also has been successful; a trial of a 6 month lifestyle intervention providing group counseling by a dietitian produced weight loss and increases in physical activity and fruit and vegetable consumption (39).

Our study has limitations which should be considered when interpreting the results. The study was a single arm study to investigate mechanisms of physical activity adoption, rather than a randomized trial to test the effect of the intervention. Without a control group we cannot rule out the possibility that other factors accounted for the changes that occurred. Additionally, only survivors who were not meeting recommendation for aerobic physical activity were eligible for this study, so it is possible that our results would not be applicable to survivors who are already physical active. However, only 10% of the survivors who were screened for the study were sufficiently active to be excluded.

Overall, home based exercise interventions benefit endometrial cancer survivors' QOL, including survivors whose BMI is in the obese range. While obese survivors may have lower exercise levels and fitness overall, and may require more support for making changes, in this study they experienced similar QOL and mental health benefits. Exercise should be encouraged in endometrial cancer survivors, including those who are obese.

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Research Highlights

- Obese survivors were less active at baseline, and had lower fitness, higher systolic blood pressure, and poorer quality of life.
- A 6-month exercise program for endometrial cancer survivors improved their quality of life.
- Changes in quality of life during the program did not differ by obesity status.

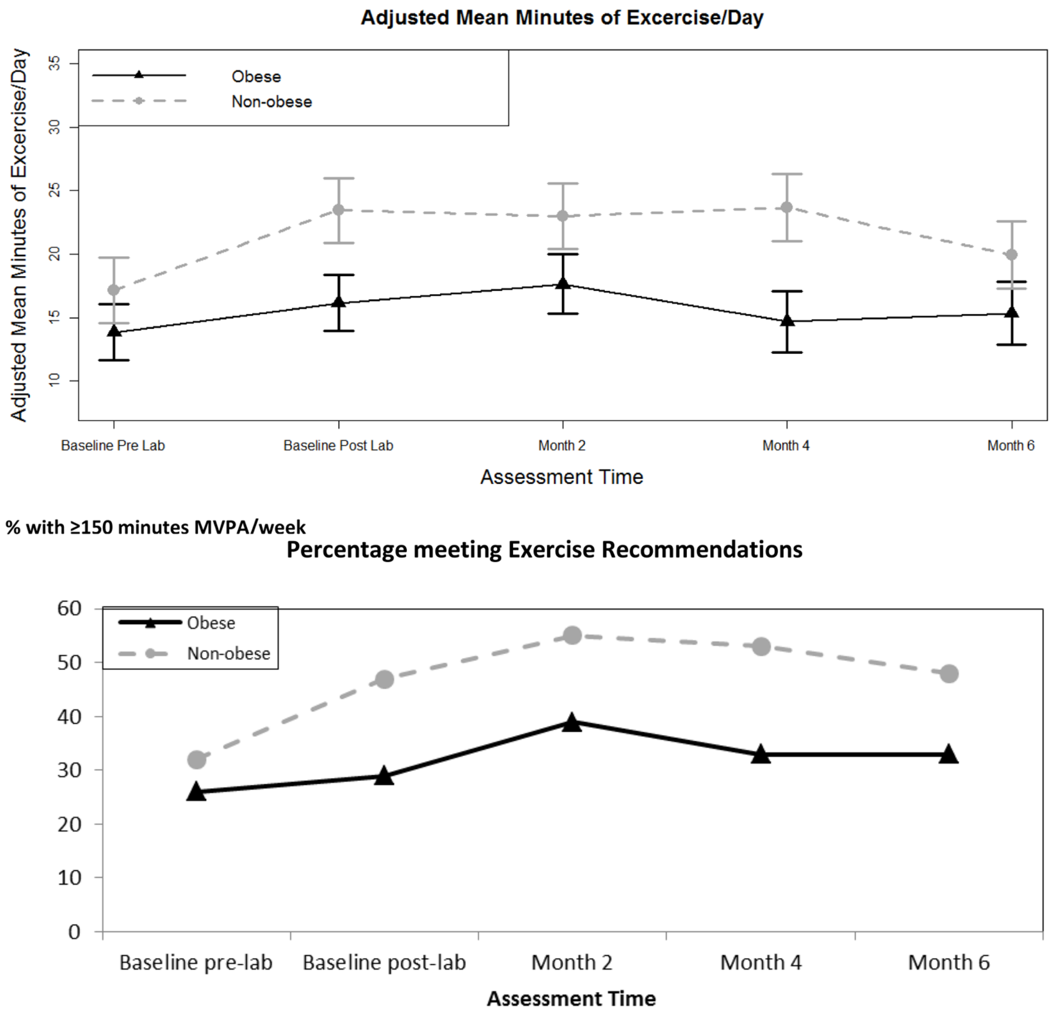

Figure 1. Adjusted[1] means for minutes of exercise per day, and percentage of participants meeting physical activity recommendations (≥150 minutes of moderate to vigorous intensity physical activity [MVPA] per week) by assessment time[2]

[1] Adjusted for age, education, race, time since diagnosis, disease stage, and treatment type (surgery, surgery plus radiation, or surgery plus other treatment). Adjusted means are based on a repeated measures model where observations are nested within individuals and assessment time. Time trend effects were not examined in this model.

[2]Minutes of activity was measured pre and post lab assessment for each assessment time. Participants were given recommendation for exercise after their baseline lab assessment. Hence, minutes of activity measured pre lab (true baseline) and post lab (during intervention period) are both considered in the model. Thus, five time points are considered for the minutes of activity repeated measures model (baseline pre lab, baseline post lab, month 2, month 4, and month 6).

Table I

Characteristics of the sample

Characteristic		N (%)	Mean (SD)	Range
Race	Black/non-Hispanic	7 (7)		
	White/non-Hispanic	75 (75)		
	Asian/non-Hispanic	5 (5)		
	White/Hispanic	12 (12)		
	American Indian/non-Hispanic	1 (1)		
Education	< High school	2 (2)		
	High school diploma/GED	13 (13)		
	Technical/vocational degree	8 (8)		
	Some college/Two-year degree	36 (36)		
	Four-year degree	24 (24)		
	Advanced degree	17 (17)		
Disease stage	I	80 (80)		
	II	16 (16)		
	IIIa	4 (4)		
Treatment	Surgery only	58 (58)		
	Radiotherapy only	0 (0)		
	Surgery + Radiotherapy	42 (42)		
Age, years			57.0 (10.96)	25–76
Time since diagnosis, years			2.22 (1.27)	0.52 – 5.22
Body mass index, kg/m^2			34.2 (9.4)	18.7–69.3

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Table 2

Baseline differences in fitness, physical activity, and quality of life between obese and non-obese survivors

	BMI <30	BMI ≥30		
	Mean (SD)	Mean (SD)	P value (unadjusted)	P value (adjusted)[1]
[2] BMI*	25.45	39.31		
Waist circumference*	81.80	110.52	<.001	<.001
Cardiorespiratory fitness* (predicted $VO2_{max}$ based on RPE)	21.75	17.00	.005	.002
Cardiorespiratory fitness (predicted $VO2_{max}$ based on heart rate)	23.05	18.38	<.001	<.001
Resting heart rate	70.64	70.32	.883	.796
Systolic blood pressure	127.22	133.45	.108	.018
Diastolic blood pressure	76.46	75.87	.772	.839
Minutes of exercise/day, past 7 days	16.42	13.24	.199	.171
Quality of life – SF-36[3]				
Physical functioning*	84.40	69.18	<.001	<.001
Mental health	76.11	75.10	.753	.939
Vitality	58.19	51.69	.132	.065
Role limitations, physical health	71.53	69.14	.758	.442
Bodily pain	76.11	65.97	.032	.037
General health	76.87	63.85	<.001	.002
Social functioning	86.81	81.84	.265	.310
Role limitations, emotional health	77.78	71.88	.463	.573
Quality of Life – QLACS[4]				
Negative feelings	11.33	11.49	.865	.977
Positive feelings	21.47	20.80	.485	.642
Cognitive Problems	11.19	10.88	.729	.651
Pain	8.72	11.06	.010	.019
Sex Problems	13.20	12.27	.482	.325
Energy/Fatigue	14.58	14.97	.533	.535
Social avoidance	8.25	9.64	.167	.174
Financial problems	6.28	8.40	.044	.122
Benefits	17.53	18.51	.436	.834
Distress-Family	2.73	3.13	.265	.313
Appearance	5.97	6.02	.943	.688
Distress-Recurrence*	9.41	12.74	.002	.011
Psychological distress (BSI-18)[4]				
Depression	2.31	3.66	.076	.114
Anxiety	3.17	3.50	.652	.848
Somatization	1.64	3.29	.004	.002

	BMI <30	BMI ≥30		
	Mean (SD)	**Mean (SD)**	**P value (unadjusted)**	**P value (adjusted)[1]**
Perceived stress[4]	23.02	21.67	.409	.322

Note: Folded F-tests were performed to test equal variance assumption between two samples. An asterisk (*) next to the variable name indicates that the assumption of equal variance was rejected, and t-test were performed assuming that the two samples have unequal variances.

[1]Adjusted for age, education, race, time since diagnosis, disease stage, and treatment type (surgery, surgery plus radiation, or surgery plus other treatment).

[2]Statistical tests are not performed for BMI, since the obesity status was defined as BMI ≥30.

[3]For SF-36 subscales, higher scores indicate better QOL.

[4]For QLACS, BSI-18, and Perceived Stress, higher scores indicate higher levels of the measured construct.

Table 3

Repeated measures analysis[1] for variables of physical activity, functioning, and measurement.

Variable	Group	Baseline	Month 2	Month 4	Month 6	Group difference		Change over time		Quadratic Change over time		Group x time interaction	
		Mean [2] (SD)	Mean (SD)	Mean (SD)	Mean (SD)	F(df)	P	F(df)	P	F(df)	P	F(df)	P
Minutes of Excercise[3]	Obese	*Pre Lab* 13.64 (12.48)	17.31 (11.41)	15.53 (10.06)	15.88 (10.64)	2.01 (1,89)	0.160	10.57 (1,318)	0.001	9.37 (1,318)	0.002	0.23 (1,318)	0.635
		Post Lab 16.06 (11.44)											
	Non-obese	*Pre Lab* 16.35 (9.90)	22.23 (12.52)	23.26 (12.22)	19.80 (10.14)								
		Post Lab 23.02 (12.60)											
Cardiorespiratory fitness (predicted VO2max based on RPE)	Obese	17.00 (5.40)	17.80 (8.81)	17.06 (5.37)	18.25 (4.47)	9.73 (1,84)	0.003	2.16 (1,201)	0.143	1.68 (1,201)	0.197	0.09 (1,201)	0.759
	Non-obese	21.75 (8.42)	23.13 (6.60)	23.42 (6.25)	22.25 (5.25)								
Waist Circumference	Obese	110.52 (13.06)	109.45 (14.74)	111.93 (15.80)	112.08 (15.93)	106.54 (1,88)	< 0.001	0.18 (1,223)	0.670	0.41 (1,223)	0.523	0.01 (1,223)	0.975
	Non-obese	81.80 (8.50)	81.64 (8.91)	81.93 (9.84)	81.42 (9.86)								
Resting Heart Rate	Obese	70.32 (10.16)	68.96 (9.62)	69.34 (10.30)	69.15 (11.28)	0.45 (1,89)	0.505	5.86 (1,222)	0.016	3.99 (1,222)	0.047	1.54 (1,222)	0.215
	Non-obese	70.64 (10.23)	67.06 (7.25)	66.25 (9.48)	66.03 (8.51)								
Systolic blood pressure	Obese	133.45 (18.52)	132.52 (15.38)	127.44 (16.45)	127.80 (13.74)	6.08 (1,89)	0.016	4.80 (1,221)	0.030	3.45 (1,221)	0.065	0.88 (1,221)	0.351
	Non-obese	127.22 (18.00)	123.77 (18.41)	121.19 (14.98)	125.55 (17.59)								
Diastolic blood pressure	Obese	75.87 (10.32)	76.70 (12.93)	74.59 (9.87)	75.08 (9.40)	0.17 (1,89)	0.684	0.01 (1,221)	0.990	0.09 (1,221)	0.768	0.25 (1,221)	0.616
	Non-obese	76.46 (7.89)	74.46 (10.63)	76.22 (8.63)	73.21 (9.68)								

[1] Adjusted for age, education, race, time since diagnosis, disease stage, and treatment type (surgery, surgery plus radiation, or surgery plus other treatment).

[2] Means and standard deviations based on all available data for each measurement time.

[3] Minutes of activity was measured pre and post lab assessments. Participants were given recommendation for exercise after their pre lab assessment. Hence, minutes of activity measured pre and post baseline lab assessments are both considered in the model. Thus, five time points are considered for the minutes of activity repeated measures model (baseline pre lab, baseline post lab, month 2, month 4, and month 6), instead of four time points in other repeated measures models reported in this table.

Table 4

Repeated measures analysis[1] of quality of life scales.

Variable	Group	Baseline	6 month	Group difference		Change over time		Group x time interaction	
		Mean (SD)	Mean (SD)	F(df)	P	F(df)	P	F(df)	P
SF-36 Physical Functioning	Obese	69.18 (23.40)	76.34 (24.57)	18.3 (1,90)	<.001	12.70 (1,68)	<.001	.01 (1,68)	.967
	Non-obese	84.40 (14.13)	90.17 (10.90)						
SF-36 Role Physical	Obese	69.14 (37.20)	75.61 (37.29)	1.27 (1,90)	.263	3.75 (1,68)	.057	.17 (1,68)	.683
	Non-obese	71.53 (36.91)	82.76 (31.41)						
SF-36 Mental Health	Obese	75.10 (16.36)	80.88 (12.25)	.06 (1,88)	.812	4.97 (1,68)	.029	.03 (1,68)	.866
	Non-obese	76.11 (14.72)	81.38 (15.32)						
SF-36 General Health	Obese	63.85 (22.25)	71.01 (20.86)	11.38 (1,89)	.001	15.10 (1,67)	<.001	.11 (1,67)	.742
	Non-obese	76.87 (13.74)	84.65 (10.5)						
SF-36 Vitality Scale	Obese	51.69 (22.18)	60.00 (20.59)	1.89 (1,88)	.172	12.27 (1,68)	<.001	1.37 (1,68)	.245
	Non-obese	58.19 (16.99)	64.14 (16.8)						
SF-36 Social Functioning	Obese	81.84 (21.93)	86.28 (19.92)	1.43 (1,90)	.235	1.08 (1,68)	.303	.01 (1,68)	.934
	Non-obese	86.81 (20.03)	90.52 (17.88)						
SF-36 Role Emotional	Obese	71.88 (38.59)	78.33 (34.22)	0.60 (1,90)	.441	1.21 (1,67)	.276	.01 (1,67)	.980
	Non-obese	77.78 (38.21)	85.06 (27.58)						
SF-36 Bodily Pain	Obese	65.97 (24.12)	73.10 (20.92)	5.37 (1,90)	.023	3.02 (1,68)	.087	.27 (1,68)	.602
	Non-obese	76.11 (18.79)	78.59 (18.40)						
QLACS Negative Feelings	Obese	11.49 (4.58)	9.95 (3.76)	.48 (1,89)	.492	12.01 (1,67)	<.001	2.62 (1,67)	.110
	Non-obese	11.33 (4.23)	8.93 (4.05)						
QLACS Positive Feelings	Obese	20.80 (4.74)	22.38 (4.60)	.02 (1,90)	.877	6.73 (1,67)	.012	.70 (1,67)	.406
	Non-obese	21.47 (4.40)	22.66 (3.87)						
QLACS Cognitive Problems	Obese	10.88 (4.47)	9.71 (3.80)	.02 (1,90)	.893	8.26 (1,69)	.005	.36 (1,69)	.552
	Non-obese	11.19 (4.31)	9.97 (3.61)						
QLACS Pain	Obese	11.06 (5.16)	9.05 (4.56)	6.29 (1,90)	.014	6.44 (1,68)	.014	.34 (1,68)	.561
	Non-obese	8.72 (3.43)	7.60 (2.65)						
QLACS Sexual Problems	Obese	12.27 (6.19)	9.78 (4.70)	.89 (1,89)	.347	9.08 (1,67)	.004	.01 (1,67)	.941
	Non-obese	13.20 (6.49)	11.45 (6.03)						

Variable	Group	Baseline	6 month	Group difference		Change over time		Group x time interaction	
		Mean (SD)	Mean (SD)	F(df)	P	F(df)	P	F(df)	P
QLACS Energy/Fatigue	Obese	14.97 (3.11)	13.80 (2.59)	.37 (1,90)	.543	6.01 (1,69)	.017	.17 (1,69)	.678
	Non-obese	14.58 (2.68)	13.80 (2.95)						
QLACS Social Avoidance	Obese	9.64 (5.06)	7.80 (3.60)	2.97 (1,90)	.088	10.81 (1,68)	.002	.17 (1,68)	.678
	Non-obese	8.25 (4.27)	6.43 (3.43)						
QLACS Financial Problems	Obese	8.40 (6.00)	7.95 (5.53)	3.47 (1,88)	.066	.01 (1,68)	.985	.23 (1,68)	.630
	Non-obese	6.28 (4.25)	5.17 (1.44)						
QLACS Benefits Subscale	Obese	18.51 (6.16)	19.10 (5.86)	.03 (1,88)	.856	7.78 (1,67)	.007	1.06 (1,67)	.307
	Non-obese	17.53 (5.59)	18.80 (5.83)						
QLACS Distress- Family	Obese	3.13 (1.81)	2.66 (1.60)	.99 (1,88)	.323	3.33 (1,68)	.072	.22 (1,68)	.639
	Non-obese	2.73 (1.46)	2.29 (1.03)						
QLACS Appearance	Obese	6.02 (2.80)	5.60 (2.47)	.08 (1,88)	.777	.98 (1,68)	.327	.04 (1,68)	.840
	Non-obese	5.97 (3.08)	5.33 (2.26)						
QLACS Distress Recurrence	Obese	12.74 (6.41)	10.85 (5.82)	6.41 (1,88)	.013	4.81 (1,68)	.032	.82 (1,68)	.367
	Non-obese	9.42 (4.07)	8.10 (3.36)						
BSI-18 Somatic	Obese	3.29 (2.80)	2.45 (2.43)	9.40 (1,88)	.003	2.74 (1,67)	.103	1.18 (1,67)	.280
	Non-obese	1.64 (2.49)	1.24 (1.27)						
BSI-18 Depression	Obese	3.66 (3.93)	2.73 (2.96)	2.84 (1,88)	.100	.08 (1,67)	.783	.01 (1,67)	.998
	Non-obese	2.31 (2.96)	2.03 (2.97)						
BSI-18 Anxiety	Obese	3.50 (3.84)	2.18 (2.85)	.01 (1,88)	.957	3.31 (1,67)	.073	.09 (1,67)	.767
	Non-obese	3.17 (2.85)	2.45 (2.37)						
Perceived Stress	Obese	21.67 (7.38)	18.90 (6.20)	.07 (1,90)	.792	17.56 (1,69)	<.001	1.95 (1,69)	.167
	Non-obese	23.03 (8.09)	18.20 (7.15)						

[1] Adjusted for age, education, race, time since diagnosis, disease stage, and treatment type (surgery, surgery plus radiation, or surgery plus other treatment).

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